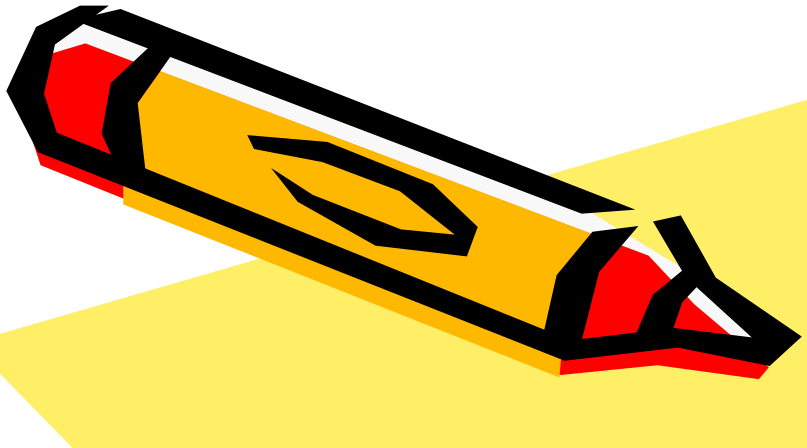
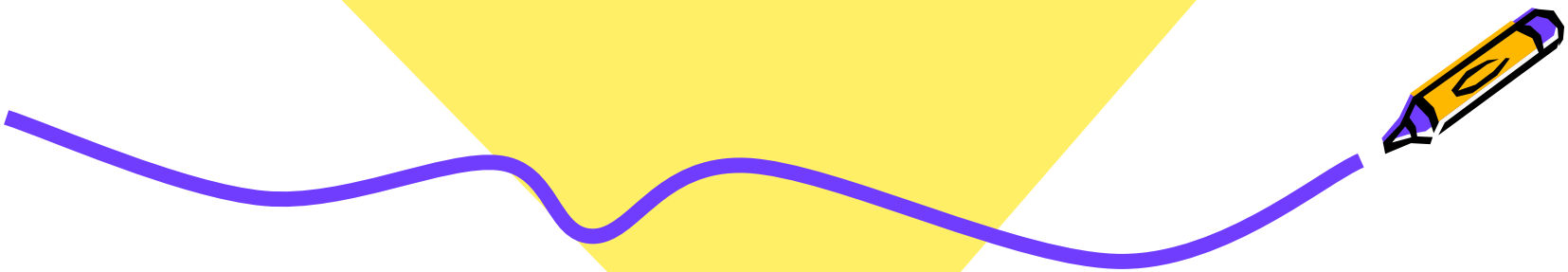


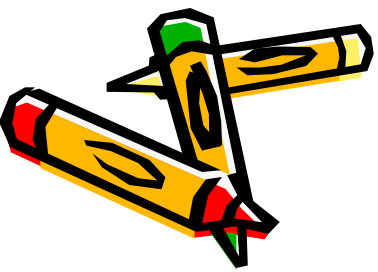
Summary of APEX, Modeling, Developments Session

M. Bai, T. Satogata



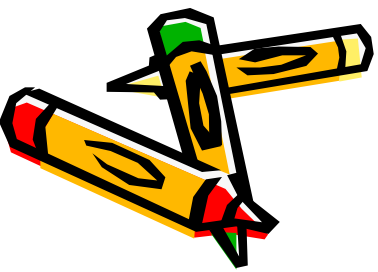
Presentations

- APEX
  - Overview of APEX, RUN 06
  - Linear optics
  - Emittance issues
  - E-clouds
  - Beam-beam issues
  - Operational feedback
  - Tune ripple
- Modeling
  - Model status and plans
  - Ramp designer for the future



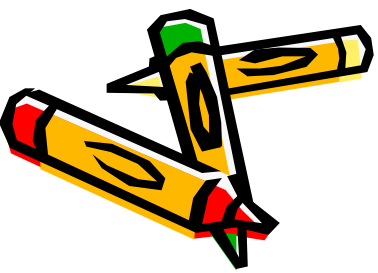
APEX summary: Fulvia

- Status of APEX
  - Overview of the time usage of APEX
  - Reminded:
    - goal of the APEX, organization(committee, website …)
    - Current mode: fixed 12h session/weekly
    - Disscussions on
      - Scattered mode
      - A mix of the two
- Overview of the beam studies during RUN06
- APEX for RUN07
  - Annual APEX workshop: end of Sept.

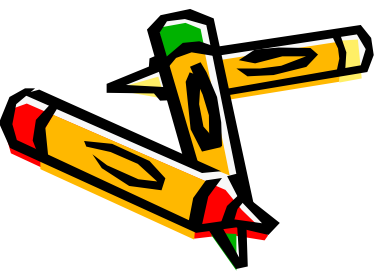


Linear Optics: Mei, Todd

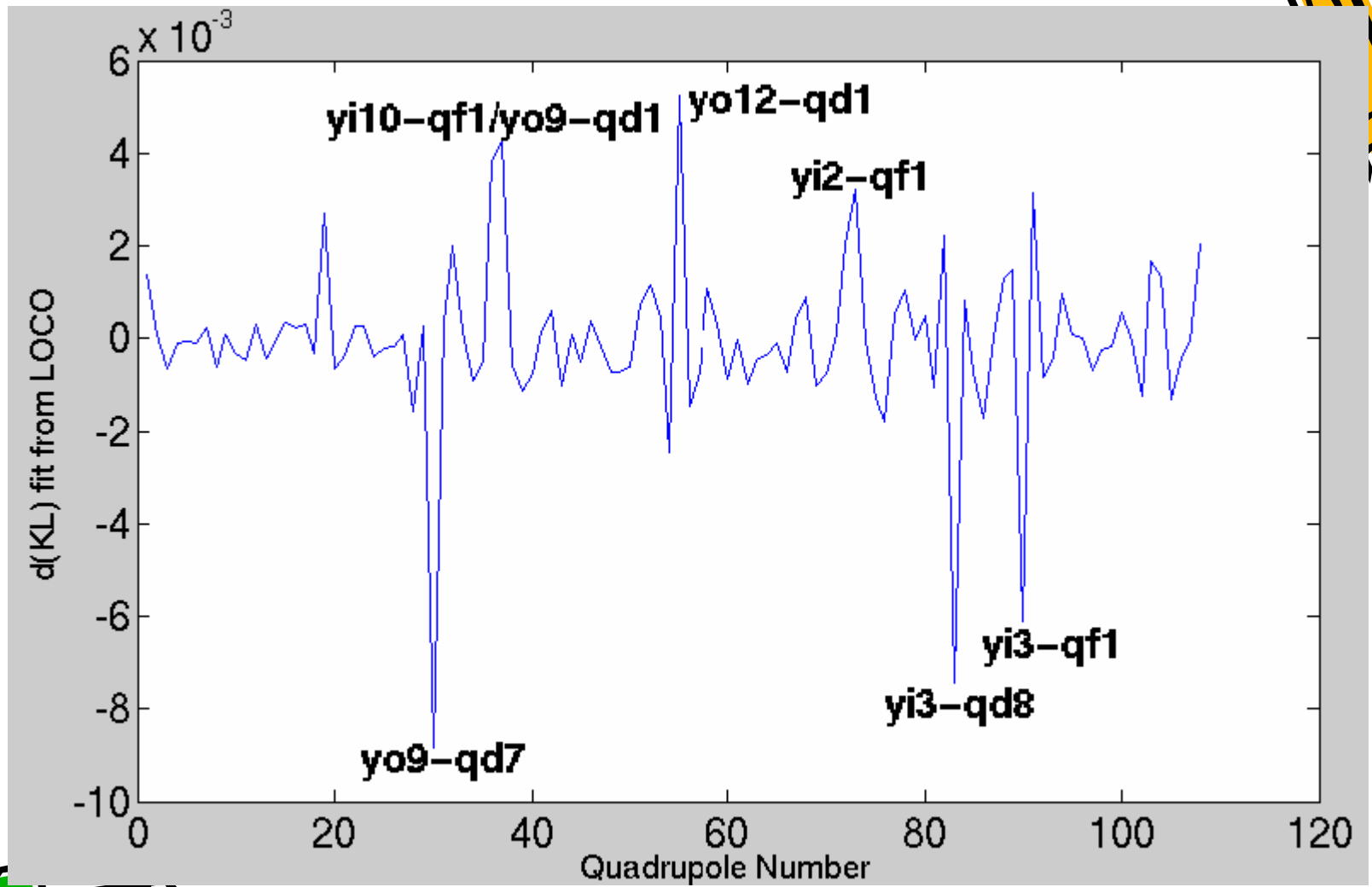
- ORM data and ac dipole data were taken during the
- Emittance control
  - Critical for run 06
  - Prevent shorter bunches



Linear Optics: Mei, Todd

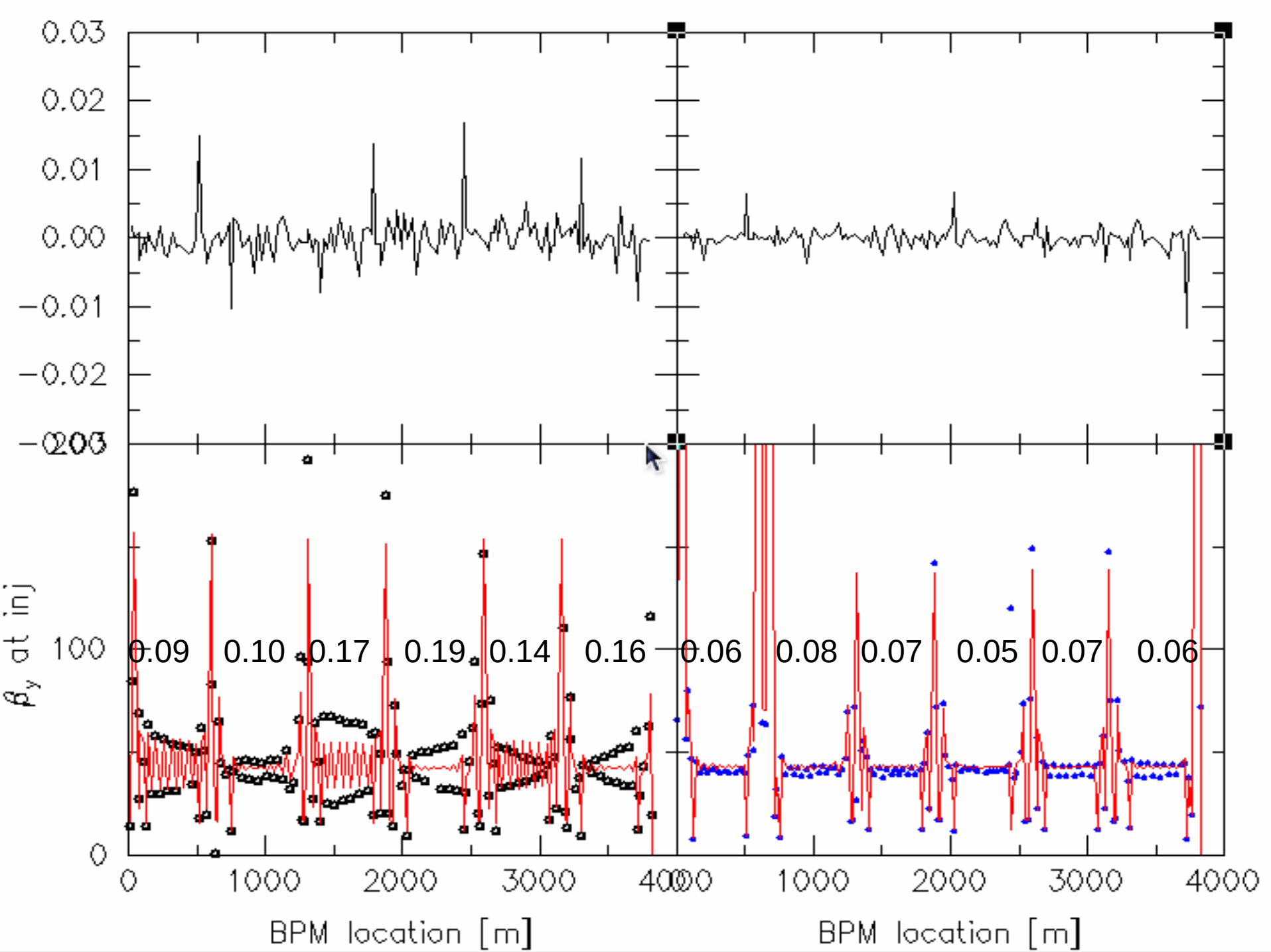


error



the gradient errors as a function of quad index in the fitting. They are at most 10 percent of the quadrupole strengths themselves

the average of d(KL) is about zero -- the ORM fit is not trying to compensation for a tune difference between measurement and model.


0.03
0.02
0.01
0.00
−0.01
−0.02
−0.03
100
0
β_y at inj
0.09
0.10
0.17
0.19
0.14
0.16
0.06
0.08
0.07
0.05
0.07
0.06
0
1000
2000
3000
4000
BPM location [m]
BPM location [m]

Plans

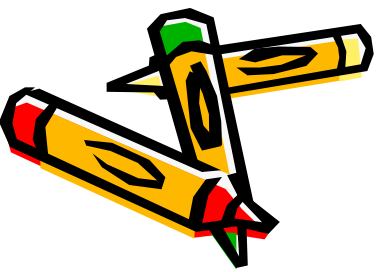
- Shutdown
  - complete the data analysis or ORM and ac dipole data
    - ORM:
      - Compare corrected yellow injection/store lattices to measured optics
        - » Include BPM and corrector gain errors in fits
        - » Include coupling
        - » Fit more quads in yellow store analysis; understand why full-ring fit

          becomes singular. Fix yellow tune matching for store ORM.
        - » Analyze Blue store data from May 30
        - » Analyze May 30 data for both rings with averaged orbits
        - » Analyze AGS data with Matlab LOCO
      - Ac dipole: understand the linear optics dependence on the coherent size
  - Comparison of the two methos
  - Design gradient error correction scheme
- With beam
  - Dedicated beam time
    - Gradient error measurement methods
    - test the gradient error correction scheme

Emittance: Vadim

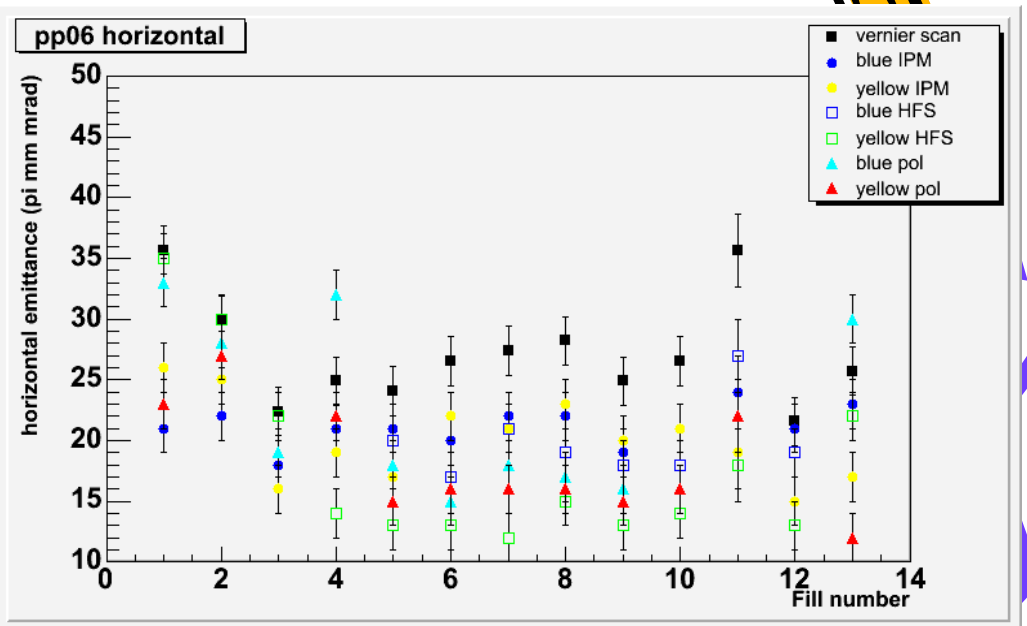
- Observations
  - Emittance growth at injection
    - During injection: injection kicker timing
    - Conitnuous growth: no specific smoking gun though did find the correlation with the bunch length. E-cloud could be another candidate(?)
  - Emittance growth during ramp
    - IPM data.
    - Growth seems only during the energy ramp and carrys a similar shape with the bunch length during ramp.
    - No obvious candidate. E-cloud?
  - Emittance growth at store
    - E-Cloud
    - Beam-beam

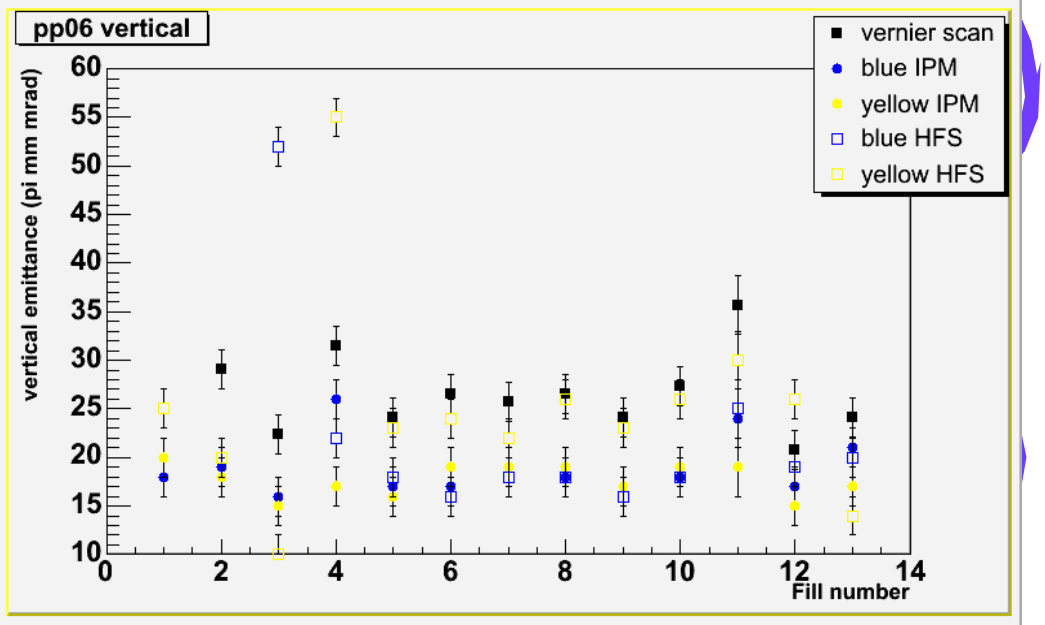
- Emittance control
  - Critical for run 06
  - Prevent shorter bunches



Emittance: Vadim

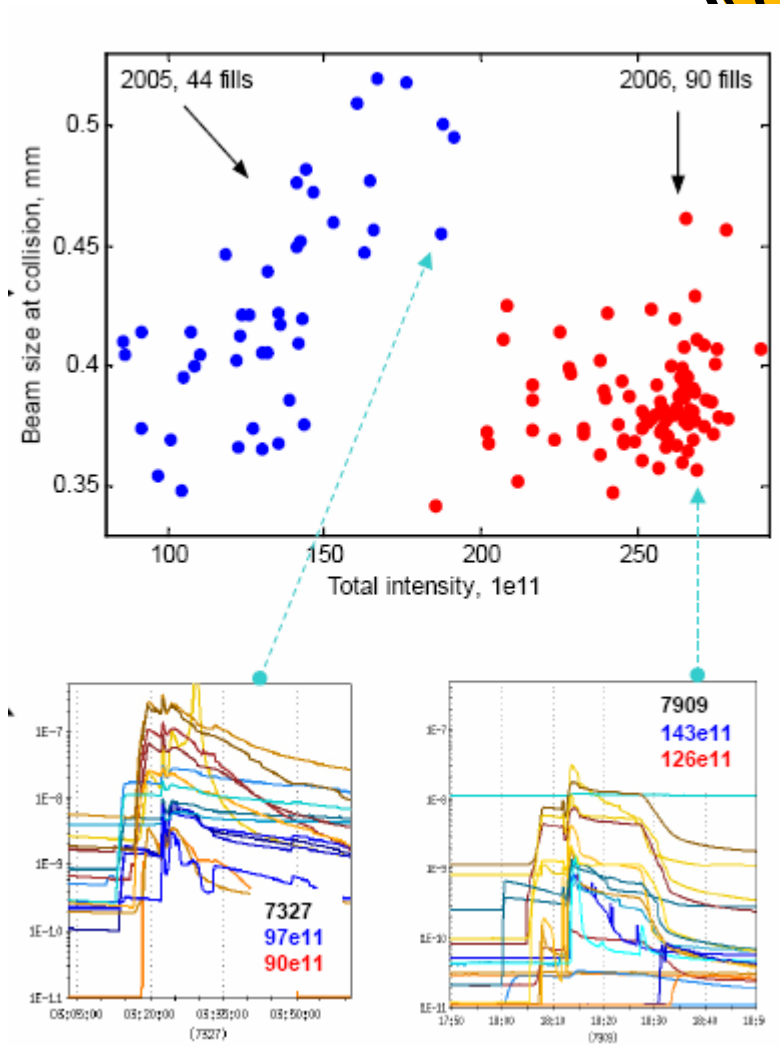
- Comparison of emittance measurements with different tools of IPM, CNI polarimeter, Vernier scan, Schottky
  - IPM/CNI close to 1.0, vernier scan shows much larger beam size
  - No correlation with the bunch length: eliminate the hour glass
  - Working progress





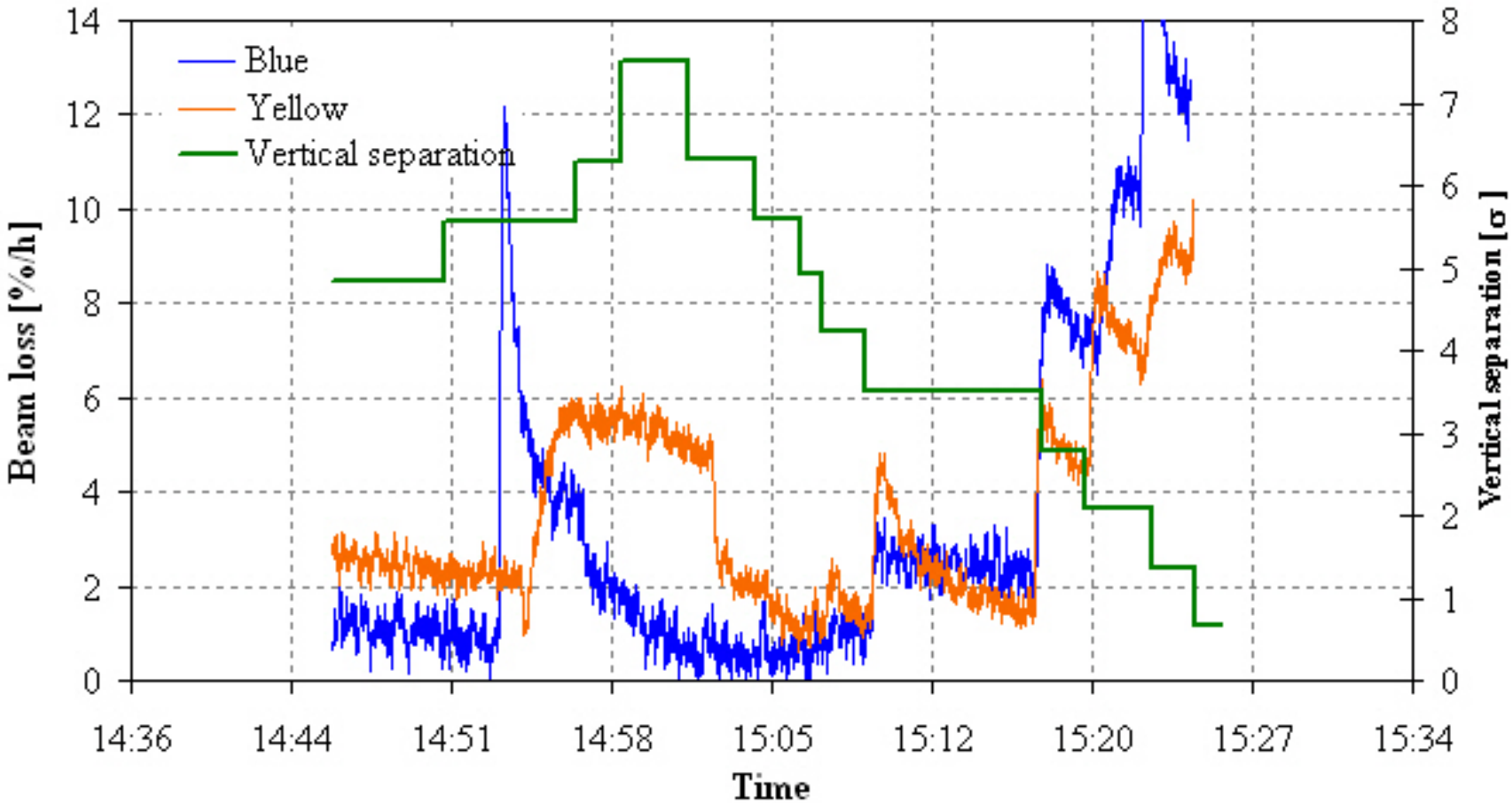
E-Cloud: SY

- EC → dynamic pressure rise
- Comarison of RUN05 and RUN06
  - the emittance growth seems to agree with the pressure rise pattern: ECloud
  - Improvement of pressure rise not only the locations with NG pipes but also other areas
- For Run07:
  - an additional 150m NG pipe for yellow



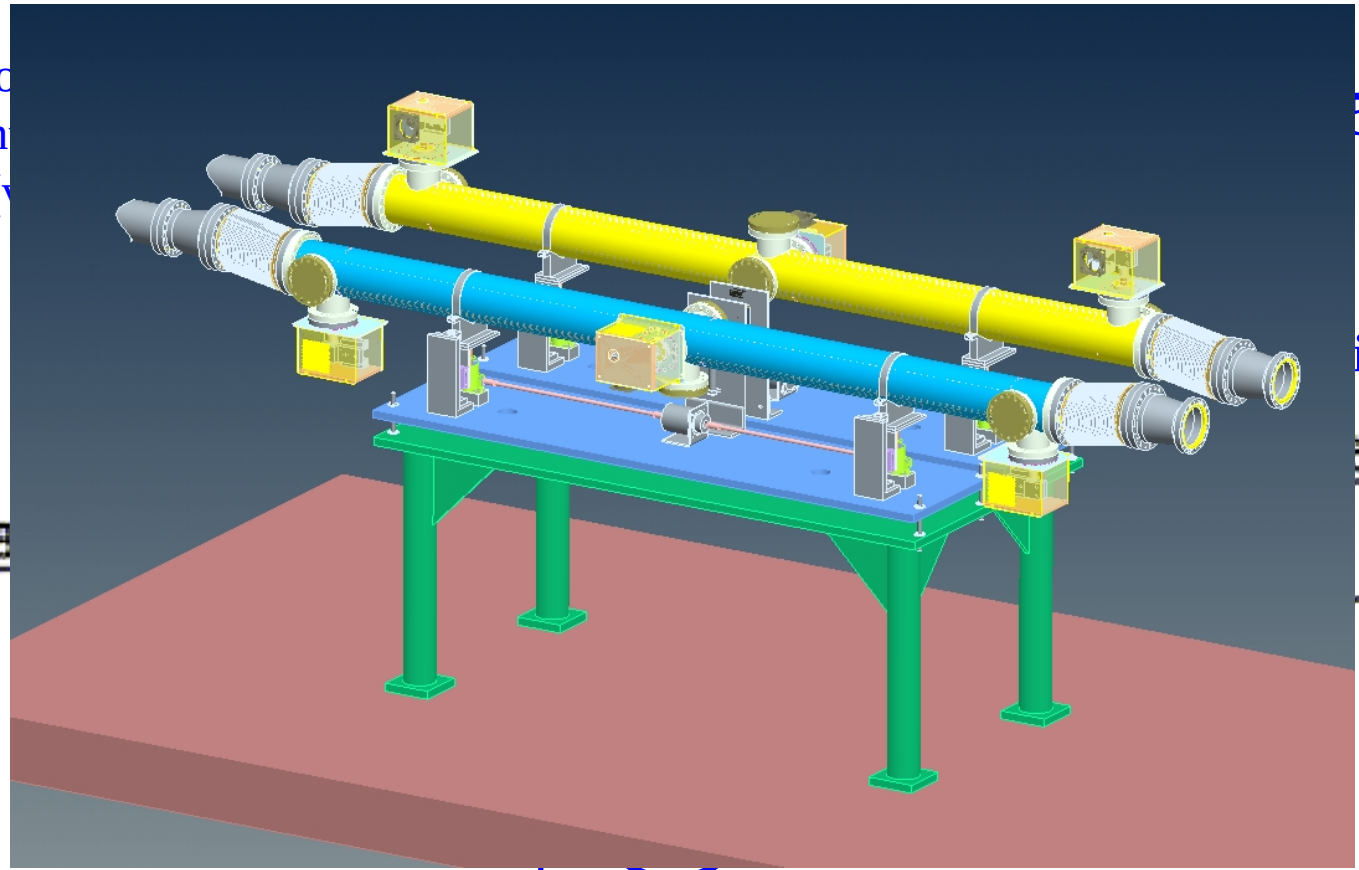
Long range beam-beam: Wolfram

- No problem now. Could be a problem for >120 bunches
- Test bed for LHC and eRHIC…
- Found a setup which allows measurable effects



Long range beam-beam: Wolfram

- Plan to install the wire compensator in 2006 summer



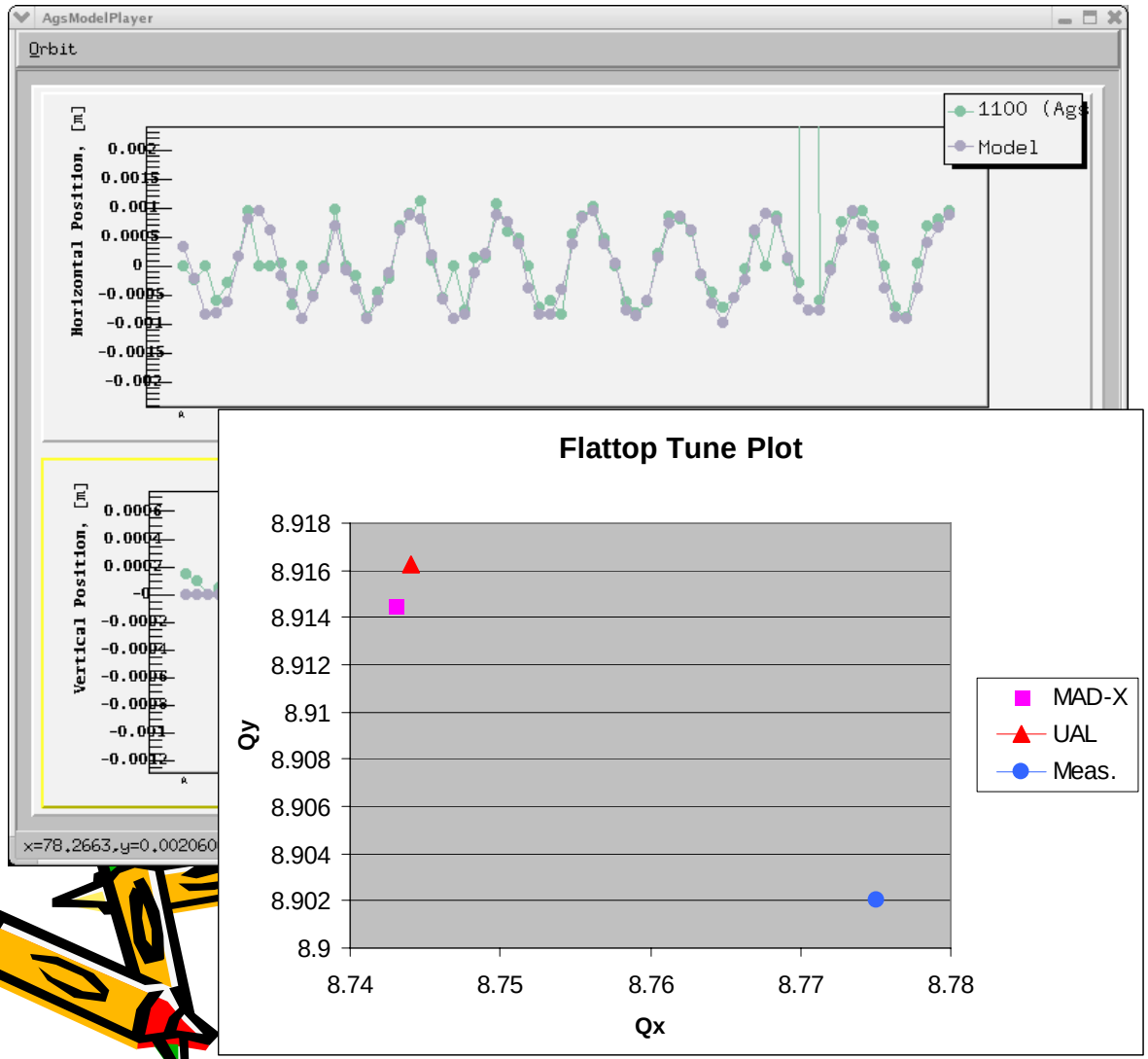
IP6

yo5

long-range
compensation
(down)

Modeling: Nikolay

- Bring RHIC online model to AGS enviroment



Conditions:

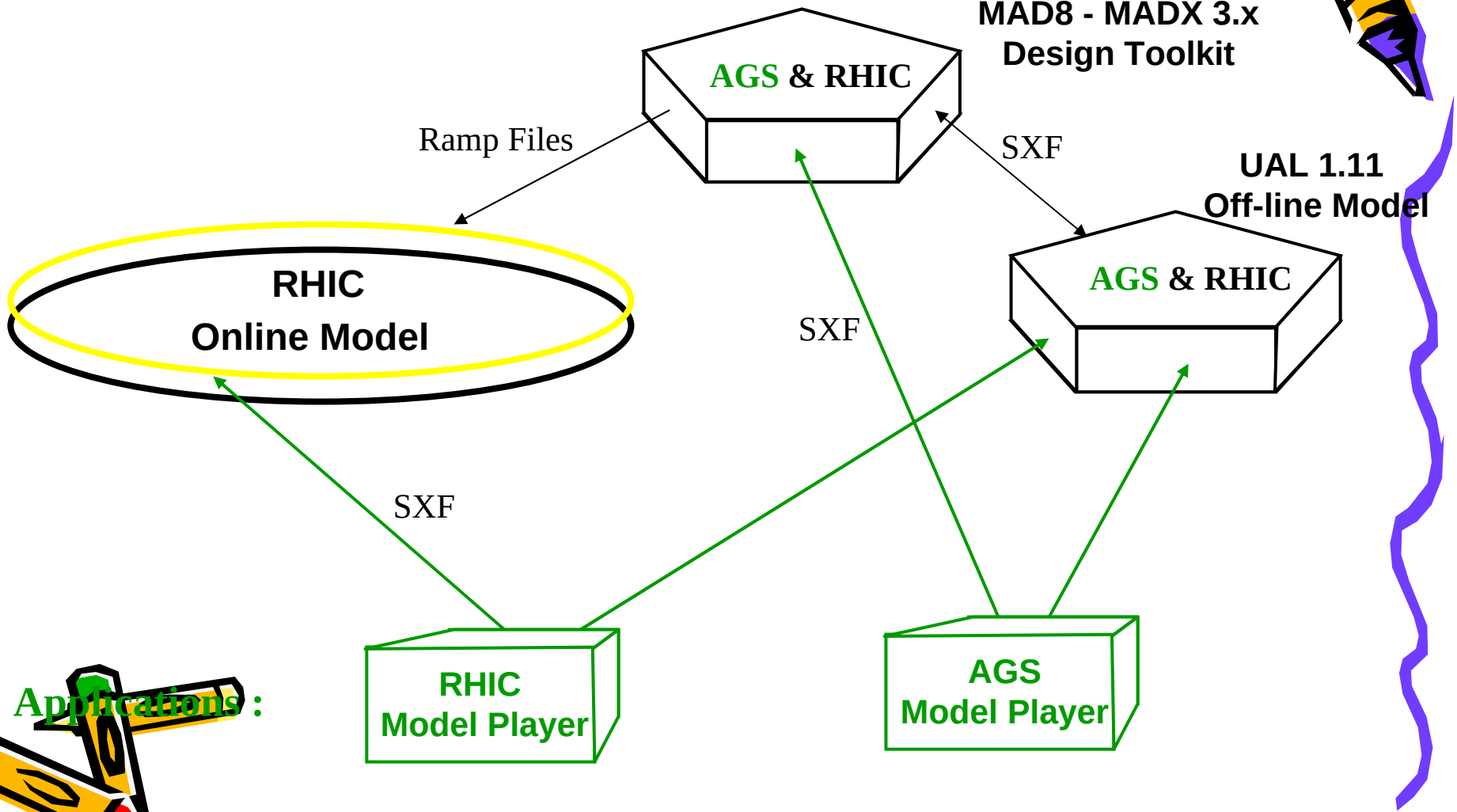
- Live machine settings.
- Dif. orbit with single corrector kick (C08)
- Snakes = drifts.

Results:

- Good orbit agreement.
- Large tune difference (model-measured)
  - dQx = -0.03
  - dQy = 0.01
- UAL agrees with MAD-X to ~1.5e-3.

AGS and RHIC Models

- 2005-2006 development



Next Step

- RHIC OrbitCalc applications
  - Merging the RhicOrbitDisplay application with the OrbitCalc library and extensions
  - Automating the orbit correction before cogging by extending the RHIC Sequencer with the OrbitCalc-based application.

- AGS Extraction model

- Refining the AGS extraction model (gradients, etc) and horizontal and vertical optics based on the orbit response matrix (ORM) measurements.

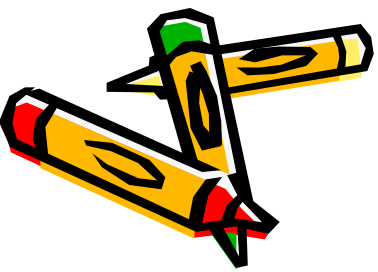
- AGS Injection model

- Reconsidering the cold snake bump optimization based on the analysis of snake models calculated with the different initial orbits.
- Refining the AGS injection vertical optics based on the orbit response matrix (ORM) measurements.

Ramp Designer: Tepikian

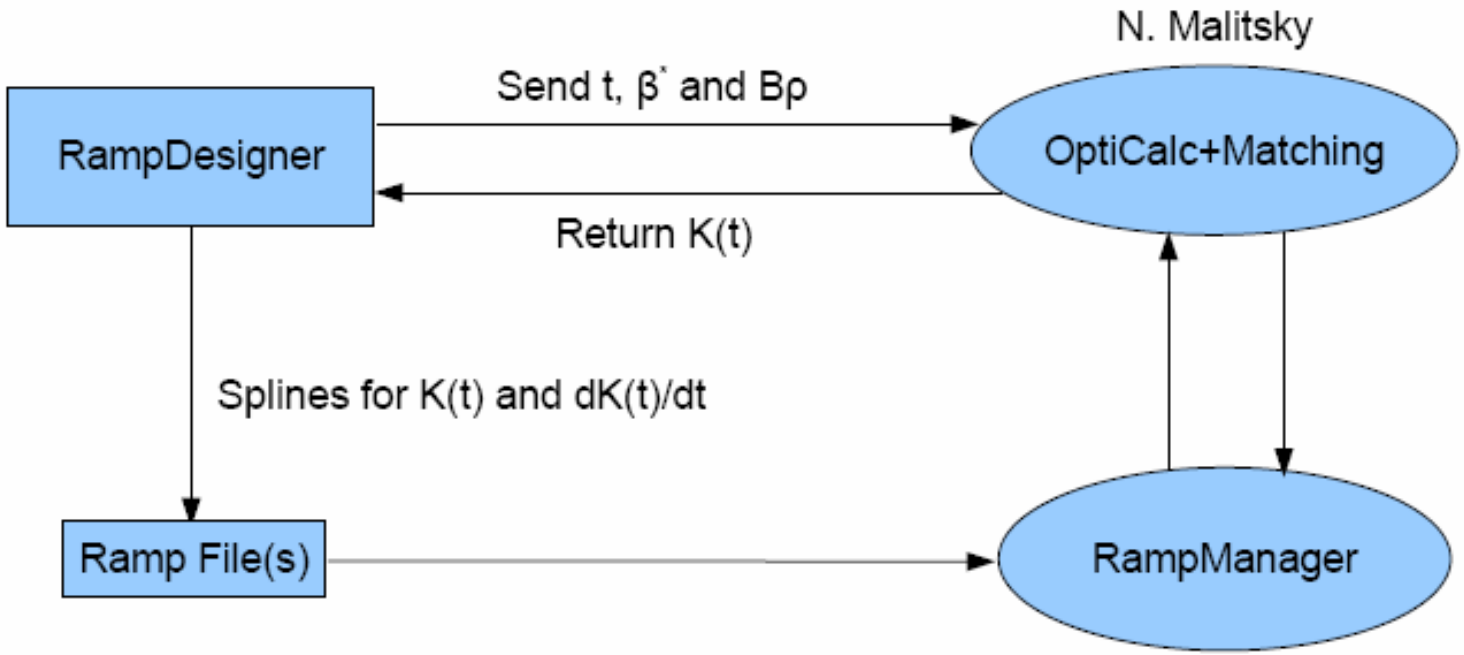
- Overview the currently what are involved for designing a ramp
  - Many scripts
  - A lot of manunal edittings/manipulations
  - Beta* fitting routine
  - Leave room for mistakes

- Ramp Designer applications
  - Provide basic functionalities that the current scripts have
  - Involve the OptiCalc+Matching for beta* fitting
  - Incooperate the limits(current as well as ramping rate) for individual powersupplies
  - Expert tool



Ramp Designer: Tepikian

Fitting will use the ***Model library*** for the expected operating conditions (γ_T quads, crossing angles, etc) to produce a ***table*** **quadrupole strengths** versus **accramp time**.



Tune ripple: Kevin Brown

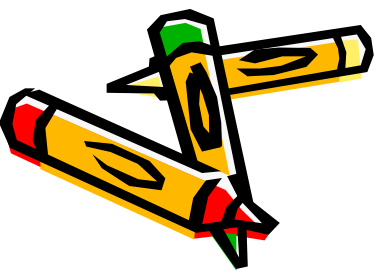
- Source
  - Main dipole
  - Quadrupole
  - Beam-beam
- Experiment
  - Use ac quadrupole
- All 3 systems
  - 1st priority is to use common software analysis
- LF
  - eliminate labview in link
  - mux control directly from Schottky manager
  - need reliable BPM "zero'ing" (always on)
- HF
  - keep labview for data collection only
  - analysis will be done in manager
- TWC
  - still under development.

Tune/decoupling feedback: Pete Cameron

- Dynamic Range **done**
  - ~180dB (or more) required
  - solution - Direct Diode Detection (3D) AFE
- Coupling **done**
  - drives tune feedback loop unstable
  - solution – continuous coupling measurement and feedback
- 90 degree phase jumps **in the works**
  - digitizer clock loses synchronization
  - solution – fit phase to chirped BTF
  - Laster's phase jump correction amplitude fitting
- Mains Harmonics **in the works?**
  - direct excitation of betatron resonance by high harmonics of power supply frequencies
  - mechanism is not yet understood
  - amplitude is ~70dB above 3D AFE noise floor during ramping
  - solution??? just live with it?
- Chromaticity **in the works**
  - modifies Beam Transfer Function portion of overall loop gain affects system stability, tracking ability,…
  - solution – continuous chromaticity measurement and feedback
  - BBQ is more sensitive to chromaticity than 245MHz PLL

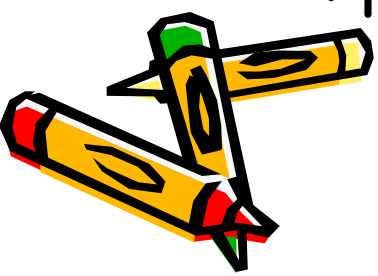
Tune ripple: Kevin Brown

- HF Schottky
  - No changes from last year
  - New emittance calibration tested in run06
  - continue software analysis development
- LF Schottky
  - Swept frequency analyzer performs well.
  - Initial new signal analysis tested and works well. Needs further work.
  - eliminate the Labview link.
- Tune ripple experiment
  - Require BBQ for 10^{-5} resolution

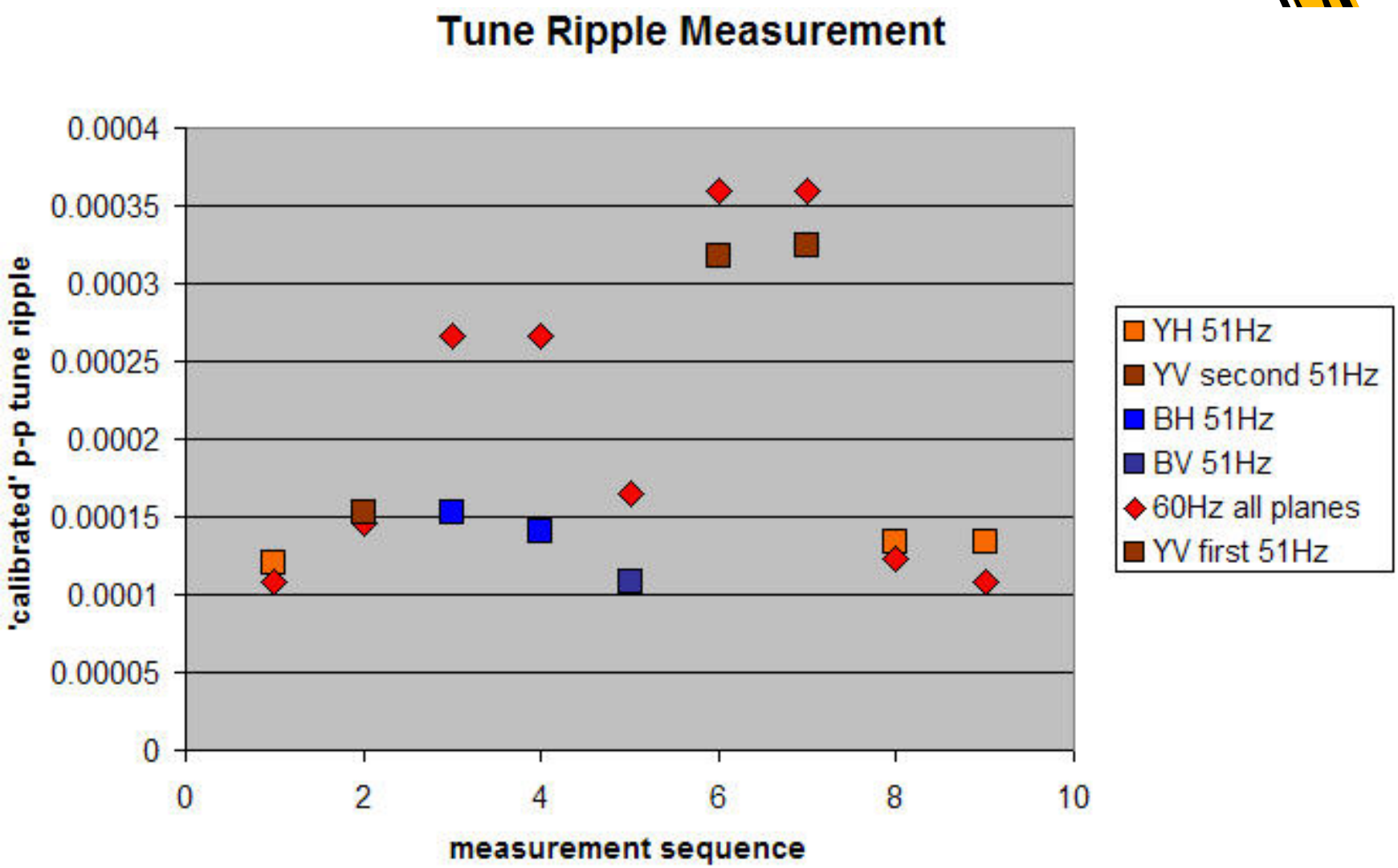


Tune ripple: Kevin Brown

- both rings at store
- Provide a carrier
  - generate coherent betatron line by locking BBQ
  - BBQ bandwidth must be less than mod frequency ~51Hz
- Modulate the tune with AC quadrupole
  - mod frequency ~51Hz
  - mod depth ~1.38x10-4 p-p tune units
- Phase demodulate using DSA
- Compare results with calculation



Tune ripple: Kevin Brown



Future?

- Tune modulation damper using ac-quadrupole
  - HERA used feedback system for tune modulation compensation (to reduce beam losses due to beam-beam resonances) Bruning & Willeke, Phys. Rev. Letters, V.76,n20
  - current ac-dipole strength at 100 GeV is around $dQ \sim 1.4 \times 10^{-4}$ p-p (10 amp).
  - to avoid emittance growth from BBQ ping, could consider feed-forward system (open-loop).
- Not an easy exercise, but feasible. 1st need to understand what needs to be corrected.